

WHAT IS CLAIMED IS:

1. An apparatus including a radio frequency (RF) filter within a multilayered low temperature co-fired ceramic (LTCC) substrate, comprising:

a first ceramic tape layer with a first electrode pattern forming a first RF ground plane;

a second ceramic tape layer with a second electrode pattern forming a second RF ground plane;

a third ceramic tape layer positioned between said first and second ceramic tape layers with a third electrode pattern including

a first sub-pattern forming a portion of a first shunt reactance including a first inductance, and

a second sub-pattern forming a first portion of a second shunt reactance including a first portion of a second inductance;

a fourth ceramic tape layer positioned between said first and second ceramic tape layers with a fourth electrode pattern including

a third sub-pattern forming a portion of a third shunt reactance including a third inductance, and

a fourth sub-pattern forming a second portion of said second shunt reactance including a second portion of said second inductance; and

a plurality of conductive vias coupling selected respective portions of said first, second, third and fourth electrode patterns;

wherein

said third and fourth electrode patterns together form at least a portion of a multiple-pole RF bandpass filter circuit with said second shunt reactance coupled intermediately to said first and third shunt reactance portions, and

corresponding portions of said first and third sub-patterns are mutually superimposed.

2. The apparatus of claim 1, wherein said second shunt reactance is coupled intermediately to said first and third shunt reactance portions by first and second reactances.

3. The apparatus of claim 2, wherein:
said third electrode pattern further includes fifth and sixth sub-patterns forming respective first portions of said first and second reactances; and
said fourth electrode pattern further includes seventh and eighth sub-patterns forming respective second portions of said first and second lumped-circuit reactances.

4. The apparatus of claim 3, wherein said respective first and second portions of said first and second reactances together comprise first and second capacitances.

5. The apparatus of claim 3, wherein:
said fifth and seventh sub-patterns of said third and fourth electrode patterns and a first portion of said fourth ceramic tape layer together form a first capacitance; and
said sixth and eighth sub-patterns of said third and fourth electrode patterns and a second portion of said fourth ceramic tape layer together form a second capacitance.

6. The apparatus of claim 3, wherein:
said fifth and sixth sub-patterns of said third electrode pattern comprise first and second capacitor plate electrodes; and
said seventh and eighth sub-patterns of said fourth electrode pattern comprise third and fourth capacitor plate electrodes.

7. The apparatus of claim 6, wherein:
each of said first, second, third and fourth capacitor plate electrodes is approximately rectangular with a corresponding major axis;
said first and third capacitor plate electrodes are mutually superimposed and said first and third major axes are approximately orthogonal; and
said second and fourth capacitor plate electrodes are mutually superimposed and said second and fourth major axes are approximately orthogonal.

8. The apparatus of claim 1, wherein:
said first shunt reactance comprises said first inductance coupled in parallel with a first shunt capacitance;
said second shunt reactance comprises said second inductance coupled in parallel with a second shunt capacitance; and
said third shunt reactance comprises said third inductance coupled in parallel with a third shunt capacitance.

9. The apparatus of claim 8, further comprising first, second and third trimmable capacitances coupled in parallel with said first, second and third shunt capacitances, respectively.

10. An apparatus including a radio frequency (RF) filter within a multilayered low temperature co-fired ceramic (LTCC) substrate, comprising:

- a first ceramic tape layer with a first electrode pattern forming a first RF ground plane;

- a second ceramic tape layer with a second electrode pattern forming a second RF ground plane;

- a third ceramic tape layer positioned between said first and second ceramic tape layers with a third electrode pattern including

- a first sub-pattern forming a portion of a first shunt reactance including a first inductance, and

- a second sub-pattern forming a first portion of a second shunt reactance including a first portion of a second inductance;

- a fourth ceramic tape layer positioned between said first and second ceramic tape layers with a fourth electrode pattern including

- a third sub-pattern forming a portion of a third shunt reactance including a third inductance, and

- a fourth sub-pattern forming a second portion of said second shunt reactance including a second portion of said second inductance; and

- a plurality of conductive vias coupling selected respective portions of said first, second, third and fourth electrode patterns;

- wherein

- said third and fourth electrode patterns together form at least a portion of a multiple-pole RF bandpass filter circuit with said second shunt reactance coupled intermediately to said first and third shunt reactance portions, and

- said second and fourth sub-patterns together form an approximately symmetrical portion of a periphery at least partially enclosing said first and third sub-patterns.

11. The apparatus of claim 10, wherein said approximately symmetrical periphery portion comprises an axially symmetrical periphery portion.

12. The apparatus of claim 10, wherein said second shunt semi-lumped-circuit reactance is coupled intermediately to said first and third shunt semi-lumped-circuit reactance portions by first and second serial reactances.

13. The apparatus of claim 12, wherein:
said third electrode pattern further includes fifth and sixth sub-patterns forming respective first portions of said first and second serial reactances; and
said fourth electrode pattern further includes seventh and eighth sub-patterns forming respective second portions of said first and second serial reactances.

14. The apparatus of claim 13, wherein said respective first and second portions of said first and second serial reactances together comprise first and second capacitances.

15. The apparatus of claim 13, wherein:
said fifth and seventh sub-patterns of said third and fourth electrode patterns and a first portion of said fourth ceramic tape layer together form a first capacitance; and
said sixth and eighth sub-patterns of said third and fourth electrode patterns and a second portion of said fourth ceramic tape layer together form a second capacitance.

16. The apparatus of claim 13, wherein:
said fifth and sixth sub-patterns of said third electrode pattern comprise first and second capacitor plate electrodes; and
said seventh and eighth sub-patterns of said fourth electrode pattern comprise third and fourth capacitor plate electrodes.

17. The apparatus of claim 16, wherein:
each of said first, second, third and fourth capacitor plate electrodes is approximately rectangular with a corresponding major axis;
said first and third capacitor plate electrodes are mutually superimposed and said first and third major axes are approximately orthogonal; and
said second and fourth capacitor plate electrodes are mutually superimposed and said second and fourth major axes are approximately orthogonal.

18. The apparatus of claim 10, wherein:
said first shunt reactance comprises said first inductance coupled in parallel with a first shunt capacitance;
said second shunt reactance comprises said second inductance coupled in parallel with a second shunt capacitance; and
said third shunt reactance comprises said third inductance coupled in parallel with a third shunt capacitance.

19. The apparatus of claim 18, further comprising first, second and third trimmable capacitances coupled in parallel with said first, second and third shunt capacitances, respectively.